(12) UK Patent Application (19) GB (11) 2 323 182 (13) A

(43) Date of A Publication 16.09.1998

(21) Application No 9805128.7

(22) Date of Filing 11.03.1998

(30) Priority Data
(31) 97008200 (32) 12.03.1997 (33) KR

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(51) INT CL^6
G03F 7/00 , G02B 6/12

(52) UK CL (Edition P)
G2X XB20B XNF

(56) Documents Cited
GB 1537634 A EP 0689094 A EP 0446672 A

(58) Field of Search
UK CL (Edition P) G2C CRN , G2X XB20B XB20X XNF
INT CL^6 G02B , G03F

(54) Abstract Title
Making optical waveguides

(57) An optical waveguide is made by applying. For a lower clad layer (102) to a glass substrate (100) a metal layer (104) is formed on the lower clad layer, and a metal pattern is formed photolithographically using photoresist (106) and then selectively etching the metal layer. Then, an optical polymer layer (110) is applied to the metal pattern, the optical polymer layer in a metal-free portion of the metal pattern is cured by irradiating UV light onto the lower surface of the substrate, and the waveguide core is formed by removing the uncured portion of optical polymer layer. Finally, an upper clad layer is formed on the lower clad layer and the waveguide (Fig 9, not shown), the waveguide core preferably having a higher R.I. than the upper and lower clad layers.

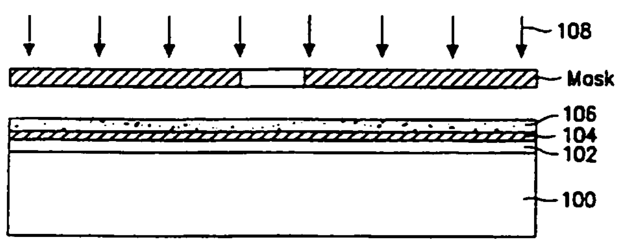

FIG. 3

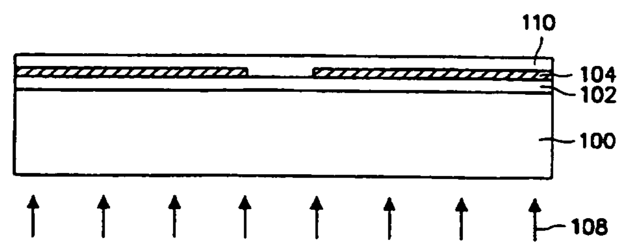

FIG. 6

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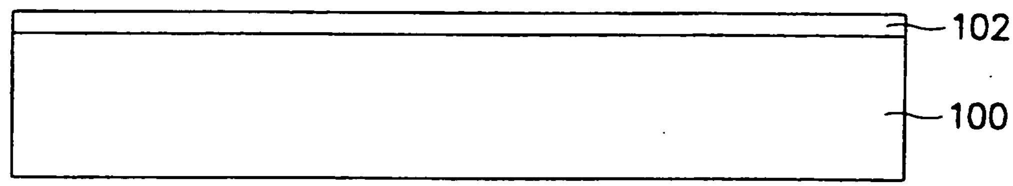

FIG. 1

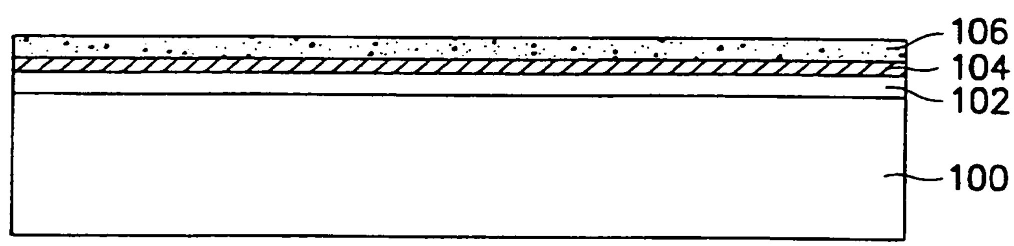

FIG. 2

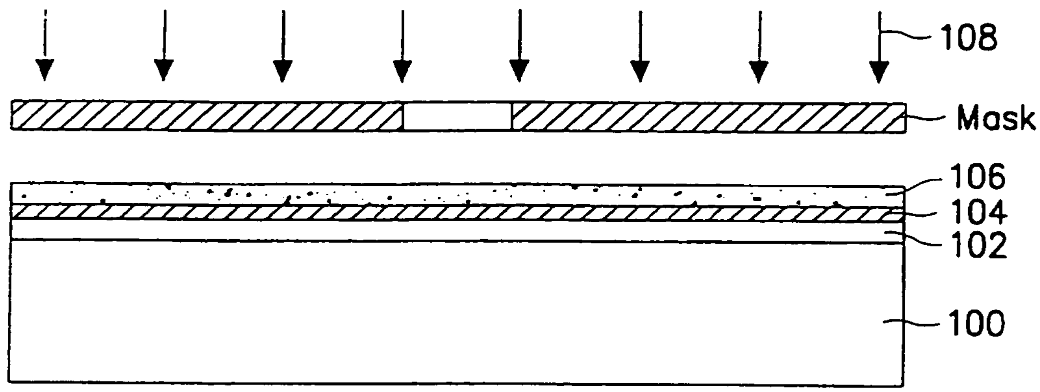

FIG. 3

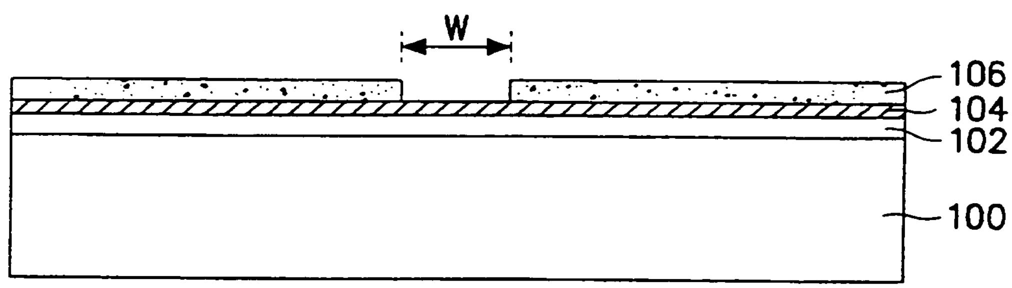

FIG. 4

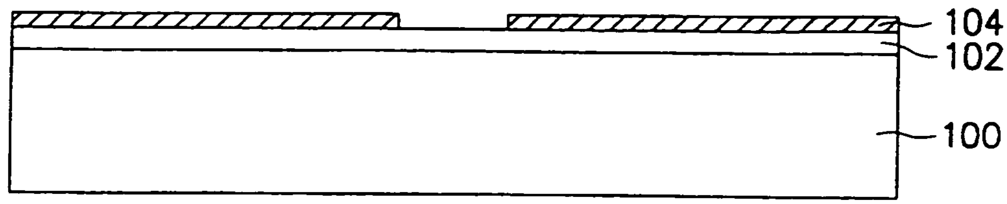

FIG. 5

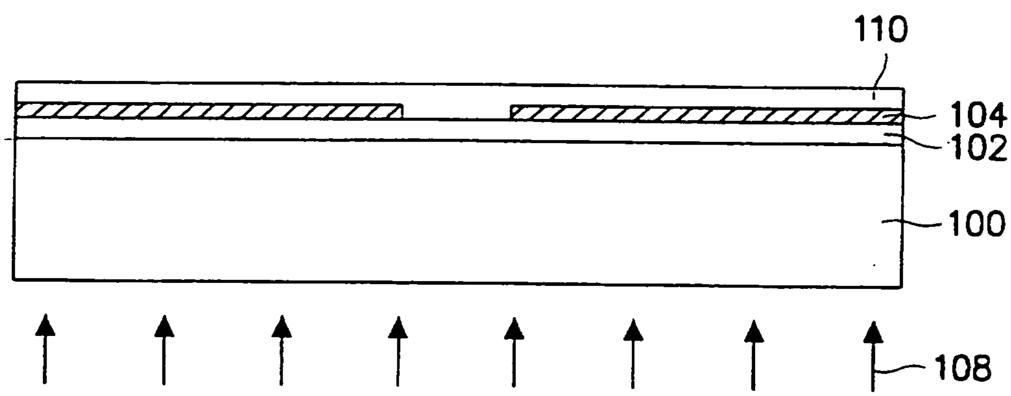

FIG. 6

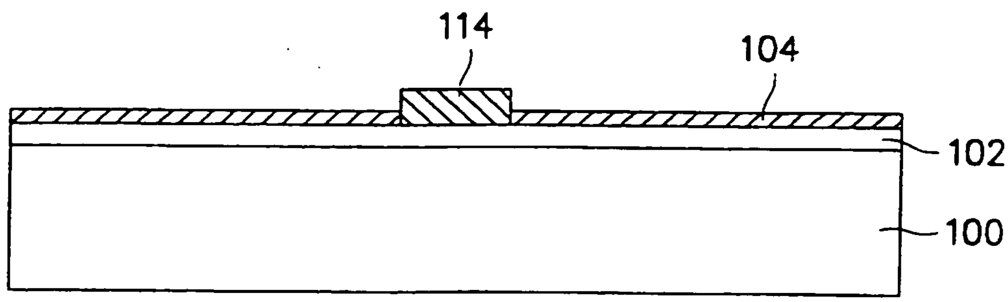

FIG. 7

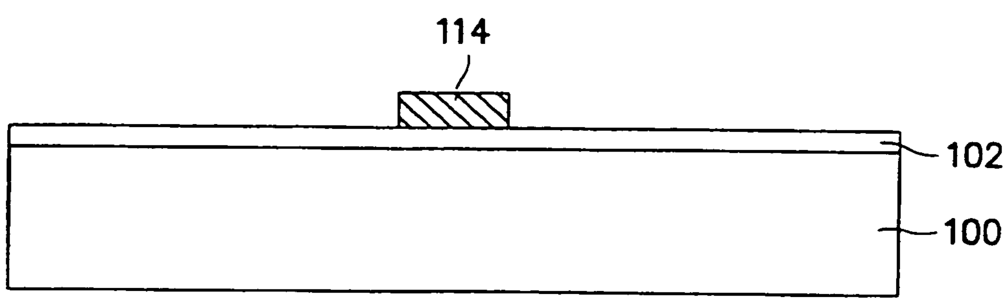

FIG. 8

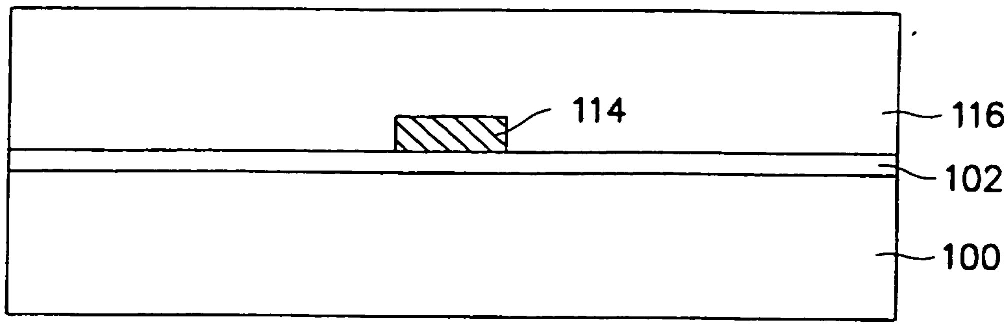

FIG. 8 9

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OPTICAL WAVEGUIDE DEVICE FABRICATION

BACKGROUND OF THE INVENTION

The present invention relates to the fabrication of optical waveguide devices using an optical polymer.

In fabrication of optical waveguide devices, optical polymers, RIE (Reactive Ion Etching), photobleaching or a poling induced waveguide method are generally employed. However, these methods require additional vacuum equipment and bring about an increase in processing time and process complexity, thus lowering product yield.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a method of fabricating an optical waveguide device which is markedly simplified by using a UV-curable optical polymer. Another object of the present invention is to provide such a method which can reduce process time without the use of additional vacuum equipment.

Accordingly, a method of fabricating an optical waveguide device according to the present invention comprises:

forming a pattern layer on a lower clad layer;

forming an optical polymer layer on the pattern layer;

curing the optical polymer layer over a pattern-free portion of the pattern layer by irradiating it through the lower clad layer;

removing the uncured parts of the optical polymer layer, and the pattern layer; and

forming an upper clad layer on the lower clad layer and the optical polymer layer.

Preferably, the lower clad layer is formed on the surface of a glass substrate. The substrate may be formed from slide glass, polycarbonate or polymethyl methacrylate. In such a case, the optical polymer layer is preferably irradiated through the substrate and lower clad layer. The

optical polymer layer may be irradiated with UV light.

Preferably, the pattern layer is formed by selectively etching a metal layer. The uncured parts of the optical polymer layer, and the pattern layer, may be removed by an etching solution.

The optical polymer layer may be formed of a linear or non-linear polymeric material having a higher refractive index than the upper clad layer and the lower clad layer.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described by way of example with reference to the accompanying drawings in which FIGs. 1-9 sequentially illustrate an optical waveguide device fabricating method according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a lower clad layer 102 is formed by depositing a clad material on a transparent glass substrate 100. Here, the substrate 100, capable of transmitting UV light 108 for curing an optical polymer layer 110, is formed of slide glass or a polymeric glass fabricated from polycarbonate or polymethyl methacrylate. The lower clad layer 102 has a lower refractive index than a given optical polymer material for forming a waveguide core 114 and is transparent in the optical wavelength range used.

In FIG. 2, a metal layer 104 is deposited on the lower clad layer 102, and a photoresist 106 is deposited on the metal layer 104 by spin coating to bury the waveguide core 114. Then, a metal pattern W corresponding to the waveguide core 114 is formed as shown in FIG. 4 by irradiating UV light 108 onto the metal layer 104 having the photoresist 106 formed on it through a mask, as shown in FIG. 3. Then, the photoresist 106 is developed by being submerging in a development solution and then baked. Thus, the metal pattern W is formed in the metal layer 104 as shown in FIG.

5.

In FIG. 6, to form the waveguide core 114, the optical polymer layer 110 is formed by depositing an optical polymer curable by UV light 108 on the metal layer 104 by spin coating. Here, the optical polymer for the optical polymer layer 110 is linear or non-linear, and has a higher refractive index than that for the lower clad layer 102 and an upper clad layer 116 and possesses low-loss optical transmissivity in the optical wavelength range used. Then, UV light 108 is irradiated onto the lower surface of the substrate 100 having the optical polymer layer 110 formed on it. As a result, with the metal layer 104 used as a mask, only a portion of the optical polymer layer 110 in the metal pattern W is cured, while the other portion remains un-cured.

In FIG. 7, when the optical polymer layer 110 is cleaned off by an appropriate etching solution, the non-cured portion of the optical polymer layer 110 is etched, whereas the cured portion in the metal pattern W avoids etching and becomes the waveguide core 114. Then, the metal layer 104 acting as the mask is etched by an appropriate etching solution as shown in FIG. 8.

In FIG. 9, the upper clad layer 116 is formed of a clad material having a lower refractive index than the waveguide core 114, on the lower clad layer 102 having the waveguide core 114, thus completing the optical waveguide device fabrication process.

Here, poling incurred by the electrical field of a non-linear optical polymer can be applied by providing transparent electrodes on the substrate 100, and the electrodes can be used for fabrication of a device relying on electro-optical effects. In addition, a metal electrode heater or a metal electrode may be formed on the upper clad layer 116 in order to fabricate a device using thermo-optical or electro-optical effects.

As described above, in the optical waveguide device fabricating method according to the embodiment of the present invention, process simplicity can be achieved by using a UV-curable optical polymer for fabrication of an optical waveguide device. In addition, the optical polymer layer and a photomask can be prevented from contamination caused by direct contact between a photomask and the optical polymer layer, through the back illumination of UV light. Formation of the metal layer to act as a mask with respect to the UV light irradiated onto the lower surface of a substrate obviates the need for aligning the photomask on the substrate, resulting in a self-alignment effect.

CLAIMS

1. A method of fabricating an optical waveguide device comprising:

forming a pattern layer on a lower clad layer;

forming an optical polymer layer on the pattern layer;

curing the optical polymer layer over a pattern-free portion of the pattern layer by irradiating it through the lower clad layer;

removing the uncured parts of the optical polymer layer, and the pattern layer; and

forming an upper clad layer on the lower clad layer and the optical polymer layer.

2. A method according to claim 1 in which the lower clad layer is formed on the surface of a glass substrate.

3. A method according to claim 2 in which the substrate is formed from slide glass, polycarbonate or polymethyl methacrylate.

4. A method according to claim 2 or claim 3 in which the optical polymer layer is irradiated through the substrate and lower clad layer.

5. A method according to any preceding claim in which the optical polymer layer is irradiated with UV light.

6. A method according to any preceding claim in which the pattern layer is formed by selectively etching a metal layer.

7. A method according to any preceding claim in which the optical polymer layer is formed of a non-linear polymeric material having a higher refractive index than the upper clad layer and the lower clad layer.

8. A method according to any one of claims 1-6 in which the optical polymer layer is formed of a linear polymeric

material having a higher refractive index than the upper clad layer and the lower clad layer.

9. A method according to any preceding claim in which the uncured parts of the optical polymer layer, and the pattern layer, are removed by an etching solution.

10. A method of fabricating an optical waveguide device substantially as described herein with reference to and/or as illustrated in the accompanying drawings.

The Patent Office

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Application No: GB 9805128.7
Claims searched: 1-10

Examiner: Meredith Reynolds
Date of search: 27 April 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G2X(XNF,XB20B,XB20X) G2C(CRN)

Int Cl (Ed.6): G02B 6/12, G03F 7/00

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0689094A	(AKZO)(Fig 1 and Col 3)	
A	EP 0446672A	(IBM)(Figs 2-3)	
A	GB 1537634	("")(Figs)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.